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OU 3-13 Tank Farm Interim Action Polyurea Demonstration Report

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Approved by

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ER Project Manager

Date

ABSTRACT

The Operable Unit 3-13 Tank Farm Interim Action is designed to mitigate the risks resulting from previous operations within the tank farm at the Idaho Nuclear Technology and Engineering Center. During the project scoping phase, polyurea, a spray-applied impermeable product, was selected as the best method available to: (1) restrict access to control exposure to workers and prevent exposure to the public, (2) minimize precipitation infiltrations, and (3) improve building drainage systems by directing water away from the contaminated areas. Three vendors were selected to participate in the polyurea demonstration with each being assigned an area to demonstrate their specific application methods. All products were applied to a variety of surface conditions simulating those representative in the tank farm and surrounding area. These conditions included asphalt, road base, uncompacted gravel, and wood or metal protrusions. Although improvements are required for application of a high friction surface and application in windy conditions, the results of the demonstration indicate that polyurea has good flexibility, strength, durability, and bonding to various surfaces.

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TABLES

ACRONYMS

EPA	Environmental Protection Agency
GP	General Polymers
IDEQ	Idaho Department of Environmental Quality
IH	Industrial Hygiene
INTEC	Idaho Nuclear Technology and Engineering Center
MDI	Methylene Biphenyl Isocyanate
MSA	Mine Safety Administration
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
ROD	Record of Decision
TFIA	Tank Farm Interim Action
UV	Ultraviolet

OU 3-13 Tank Farm Interim Action Polyurea Demonstration Report

1. INTRODUCTION

1.1 Project Background

The Operable Unit (OU) 3-13 Group 1 Soils are soils at the Idaho Nuclear Technology and Engineering Center (INTEC) within the tank farm fence. Previous operations within the tank farm have resulted in known areas of soil contamination. The major threat associated with these soils is the potential leaching and transport of contaminants to the perched water or to the Snake River Plain Aquifer. The OU 3-13 Interim Action is designed to mitigate this risk until a final remedy is developed and implemented. The selected Tank Farm Interim Action is Institutional Controls with Surface Water Control. The major components of this remedy include:

- Restrict access to control exposure to workers and prevent exposure to the public from soils at the tank farm until implementation of the final remedy under OU 3-14
- Accommodate a 1 in 25-year, 24-hour storm event with surface water run-on diversion channels
- Minimize precipitation infiltration by grading and surface-sealing the Tank Farm soils sufficient to divert 80% of the average annual precipitation falling on the Tank Farm soils area
- Improve exterior building drainage to direct water away from the contaminated areas, as promulgated in the Record of Decision (ROD) (DOE/ID 1999).

The OU 3-13 Group 1 Soils Tank Farm Interim Action consists of repair and lining of the existing surface water drainage systems, improvement of building drainage systems, construction of a lined evaporation pond, construction of a lift station and of additional drainage ditches, and sealing/covering the tank farm and 150-ft zone surrounding the tank farm to reduce run-on infiltration.

During the project scoping phase, various sealing/cover options and combinations of options were investigated for minimizing precipitation infiltration. These options were presented at a facilitated Decision Analysis Meeting to (1) discuss the options evaluated for surface sealing/covering the tank farm and surrounding areas, (2) identify additional options, if any, (3) identify evaluation criteria, (4) select a recommended option, and (5) identify the risk associated with the recommendation. An Engineering Design File (Jessmore, 2000) containing the information assimilated in the meeting and the recommended cover option selected was prepared and presented to the Environmental Protection Agency (EPA) and the Idaho Department of Environmental Quality (IDEQ) (herein referred to as the Agencies). The selected option was polyurea, which is a spray-applied impermeable product. The Agencies concurred with the recommended option, pending the results of a polyurea field demonstration, which is the subject of this report. This report documents the results of the polyurea demonstration and the assessment of the performance criteria.

2. POLYUREA DEMONSTRATION

2.1 Demonstration Objectives/Performance Criteria

In April 2000, a polyurea demonstration commenced at the INTEC, in support of the ROD, which mandates that precipitation and run-on in the tank farm and within the 150-ft perimeter areas, be directed and controlled away from the tank farm area. The demonstration was performed in accordance with the Spray-on Polyurea Demonstration Plan (Appendix A). The demonstration objectives are (1) to identify and assess minimum acceptable performance criteria for inclusion in the Tank Farm Interim Action (TFIA) construction specifications, and (2) to assess the following performance criteria: durability, strength, flexibility, safety, and ease of application.

2.2 Demonstration Details

2.2.1 Demonstration Area

The polyurea demonstration area is located inside the INTEC fence, adjacent to buildings TB-6 and CPP-654, just north of the tank farm (see Figure 2-1). Building TB-6 is an abandoned wood building. Building CPP-654 is still in use and has a galvanized corrugated metal exterior. Cedar Street, an asphalt road, is located between the two buildings. This area is within the 150-ft zone surrounding the tank farm and will therefore be sealed during the TFIA project.

The demonstration area was modified to simulate surfaces and conditions representative of those which exist in the tank farm. Metal posts were installed to simulate protrusions in the tank farm, and a portion of the gravel area was compacted. The remainder of the area consists of uncompacted gravel and asphalt. The demonstration area was divided into three smaller areas (i.e., areas 1, 2, and 3) (see Figure 2-2), each containing two different building surfaces (wood and metal), a protrusion, compacted gravel, uncompacted gravel, and asphalt.

2.2.2 General Application Information

The demonstration was performed within a work control zone established by the on-site industrial hygienist (IH). During product application, continuous air monitoring was conducted to ensure personnel health and safety, and to ensure that adequate boundaries had been established. The monitors within the work zone consisted of Mine Safety Administration (MSA) Elf sampling pumps strategically located within the work zone, downwind of the workzone, and worn by subcontractor personnel throughout the application process. Personnel within the work zone were also required to wear personal protective clothing which consisted of a bubble suit with supplied air, sturdy leather boots, rubber gloves, and safety glasses.

Three vendors were selected to participate in the polyurea demonstration. Each vendor was assigned an area (as shown on Figure 2-2), to demonstrate their specific polyurea application, geotextile installation, seaming, and anchoring methods. Two of the three vendors demonstrated application of a friction surface (required for safety considerations), and application of an ultraviolet (UV) protectant to approximately half of the individual demonstration area.

Two of the three vendors also demonstrated a cut and repair, since breaching of the polyurea cover will occur in the tank farm after the cover is installed and repair will be required. A cut and repair demonstration of the liner was not originally part of the scope. Because team personnel felt it was important to have a user friendly repair process that could be performed by INTEC personnel, a cut and repair demonstration was added to assess the ease of the patching process and the durability of the patch.

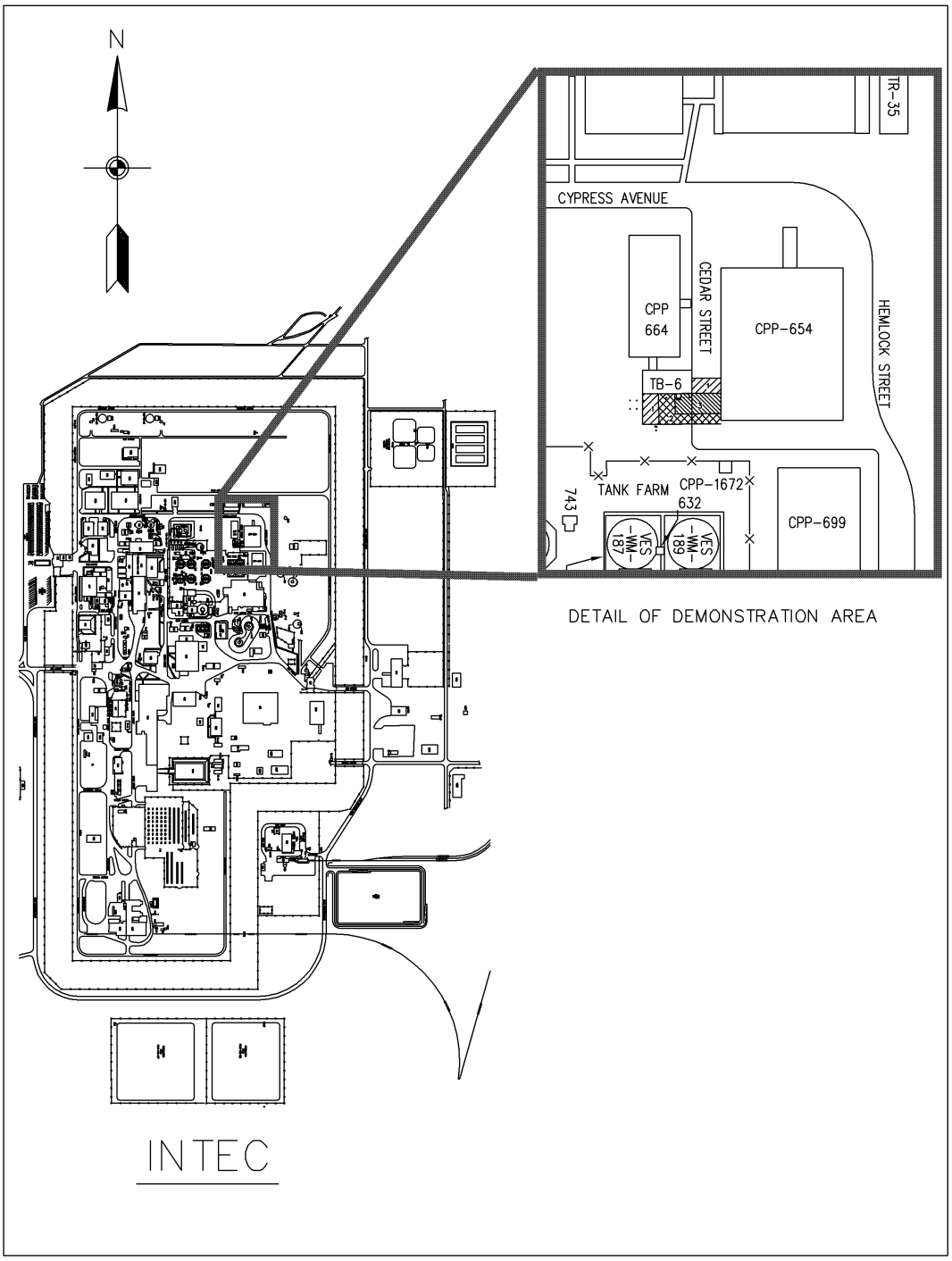


Figure 2-1. Map of INTEC with demonstration area shown.

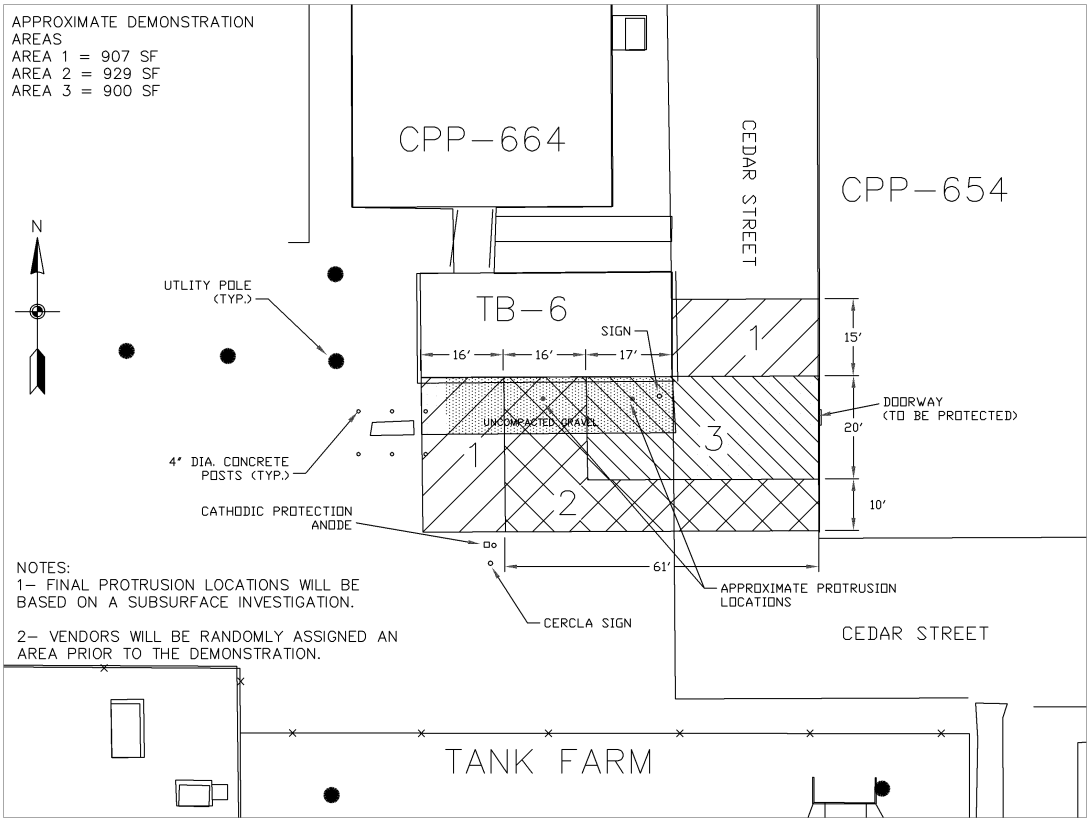


Figure 2-2. Map of demonstration area indicating vendor areas.

To aid in product distinction and color selection for the final tank farm area application, the three demonstrations were conducted adjacent to each other, each using a different color. Each of the demonstrated products were applied over an anchored geotextile (for road base and uncompacted gravel areas only) to an area approximately 900 ft^2. Product thickness is approximately 1/8 in.. Appendix B contains photographs of the demonstration area with the various polyurea products applied.

All products were applied under similar field conditions with the following exception - wind speeds were higher during Area 2 application than they were during application in Areas 1 and 3. All products were applied to asphalt, road base, uncompacted gravel, a wood or metal protrusion, and approximately 1 ft up the side of buildings TB-6 and CPP-654. These surface conditions simulate those represented in the tank farm and surrounding area.

2.2.3 Vendor Application Specifics

2.2.3.1 General Polymers. General Polymers (GP) performed their portion of the demonstration on April 27-28, 2000, in Area 3 of the demonstration area (see Figure 2-2). GP used a polyurea product known as FX 377, which for the purposes of this demonstration is black in color. Appendix C contains photographs for this portion of the demonstration.

2.2.3.1.1 Site Preparation and Polyurea Application. A significant amount of site preparation was required prior to applying the polyurea. For the asphalt area on Cedar Street, a saw cut approximately ½ in. deep was made on the north and south termination points. The area was then swept clean of all dirt and debris.

In the gravel areas, several sections of 12 ounce non-woven needle punched polypropylene geotextile were installed to cover the area. The geotextile was installed in overlapping sections, and the seams were sealed by applying polyurea between the two surfaces. To anchor the edges, the geotextile was wrapped once around lengths of rebar and anchored to the ground using 1 ft rebar sections in the shape of a seven. The geotextile was attached to building TB-6 by wrapping it around a 1 in. × 4 in. pine board and mechanically attaching it to the wood building using screws.

Geotextile was wrapped around the metal protrusion and also used to fill the gap between the asphalt road and wall of building CPP-654. The polyurea was then spray-applied to the entire area in one coat. The temperature of the polyurea during the application process was approximately 150°F. Approximately 80 gallons of polyurea was used in Area 3.

GP used a fogging method to apply the friction surface. This was accomplished by spraying the polyurea upwards, allowing droplets to form prior to bonding to the polyurea surface below. This resulted in a semi-rough surface.

Prior to application of the UV topcoat, a polyurethane tack coat was applied to approximately half of the area using a roller. This was allowed to dry for approximately one hour before applying the UV topcoat. The tack coat plus the topcoat is approximately 3-5 millimeters thick. The UV topcoat is grey in color.

Wind speeds during the polyurea application in Area 3 were 19 mph with gusts to 23 mph.

2.2.3.2 Stonhard. Stonhard performed their portion of the demonstration May 9 –10, 2000, in Area 2 of the demonstration area (see Figure 2-2). Stonhard used a ployurea product known as Semstone 403 (Stonflex XPE), which for the purposes of this demonstration is grey in color. Appendix D contains photographs for this portion of the demonstration.

2.2.3.2.1 Site Preparation and Polyurea Application. A significant amount of site preparation was required prior to spray applying the polyurea. For the asphalt area on Cedar Street, a saw cut approximately ½ in. deep was made on the north and south termination points. The asphalt was then chipped out, and the void filled with a polyurethane cementatious primer. The area was then swept clean of all dirt and debris, and a primer was rolled on the entire surface and allowed to dry overnight.

In the gravel areas, several sections of 100-millimeter thick (9.25 ounces/yd^2) non-woven needle punched geotextile known as 100 NW Contech, was installed to cover the area. The geotextile was installed in overlapping sections, and the seams were sealed by applying the polyurea between the two sections. To anchor the edges, the geotextile was wrapped twice around a strip of metal and anchored to the ground through drill holes with 18-in. metal stakes and washers on approximately 24-in. centers. A primer was roll-applied to building TB-6 and a thin strip of polyurea was applied to the upper 1 ft section. A 12-in. strip of geotextile was attached to the polyurea, creating a free-falling/moveable flashing. The lower portion of the 12-in. flashing was attached to the horizontal geotextile by applying polyurea between the lower portion of the flashing and the horizontal geotextile. Geotextile was also wrapped around the metal protrusion.

For the gap located between the asphalt road and wall of building CPP-654, a soft cell backer rod was used to fill the void. A strip of geotextile was installed over this prior to applying the polyurea.

Three coats of the polyurea were then applied to the entire area using a Gusmer pump and spray gun system under approximately 155° F heat, and 1500 psi of pressure. Approximately 85 gallons of polyurea was used in Area 2.

Stonhard demonstrated three friction surfaces; two different size silica sands (#8 and #12 mesh), and a light spray texture. The #8 size sand was applied closest to TB-6. The #12 size sand was broadcast at various densities, varying from approximately 40% in the area farthest west of CPP-654, to 100% density near CPP-654. The sand was applied using a weed blower with a hopper attached to the top. The sand was broadcast into the polyurea during application of the third coat and resulted in a semi-rough surface.

For the UV topcoat, Stonseal urethane sealer was applied using a roller to approximately 50% of Area 2. Product thickness is approximately 3-5 millimeters.

Wind speeds during the polyurea application in Area 2 were 38 mph with gusts to 45 mph. Large styrofoam boards were used to block the wind in the immediate area being sprayed, but were marginal in effectiveness.

2.2.3.2.2 Liner Cut and Repair. On August 10, 2000, Stonhard performed a cut and repair demonstration on a 5×5 ft section of Area 2. The area to be cut was first cleaned with a solvent, and an irregular cut was made on three sides using an exacto knife. The cut section was then rolled back, as if work beneath was required. The section was then placed back to the original position and three 4-in. wide strips of geotextile (similar to the one used during the demonstration) were placed over the cut edges. A two-part slow-setting brush-grade polyurea was mixed by hand in a 1:1 ratio, and rolled over the geotextile. For test purposes, two coats of the polyurea were applied to the L shaped section of the patch closest to TB-6, and one coat was applied to the remaining side of the patch, closest to the existing gravel. Appendix F contains photographs of the patching process which was completed in approximately 1/2 hour.

2.2.3.3 Sherwin Williams. Sherwin Williams performed their portion of the demonstration on May 18, 2000, in Area 1 of the demonstration area (see Figure 2-2). Sherwin Williams used a polyurea product known as Foamseal V9256/FSA64, which for the purposes of this demonstration is yellow in color. Appendix E contains photographs for this portion of the demonstration.

2.2.3.3.1 Site Preparation and Application. A significant amount of site preparation was required prior to spray-applying the polyurea. For the asphalt area, the area was swept clean of all dirt and debris, and Foamseal Z9411 Epoxy Primer was roll-applied and allowed to dry. This primer was also applied to buildings TB-6 and CPP-654. Prior to application on CPP-654, the corrugated metal was abraded with sandpaper.

In the gravel areas, a product known as Enkadrain was installed. Enkadrain consists of a high density polyethylene core of fused, entangled filaments with a woven geotextile fabric bonded to one side. The Enkadrain was laid on the ground in overlapping strips with the geotextile fabric facing up. The seams were sealed by roll-applying the Foamseal Z9411 Epoxy Primer between the overlapping strips. The Enkadrain was anchored to the ground using 1×4-in. wood strips with 10-inch nails through washers, spaced approximately 48 in. apart. One coat of the polyurea was then spray applied to the entire area using a Gusmer 3500 pump system. Approximately 100 gallons of polyurea was used in Area 1.

Although Sherwin Williams did not demonstrate a friction surface or a UV protectant top coat, they have these capabilities, and have provided samples of such.

Wind speeds during the polyurea application in Area 1 were 8 mph with gusts to 12 mph.

2.2.3.3.2 Liner Cut and Repair. On July 17, 2000, Sherwin Williams performed a cut and repair demonstration on a 5×5 ft section of Area 1. Three sides of this section were cut, and the cut section was rolled back, as if work beneath was required. The section was then placed back to the original position and the three edges were cleaned using a liquid product known as Lap Prep. A strip of filter fabric, which overlapped the damaged area, was laid down and a thick bead of Penatron 3003 was applied with a manual gun and smoothed into the fabric using a wide putty knife. A second coat of Penatron was applied to complete the patching process. The patching process was completed in approximately one hour. Appendix G contains photographs of the patching process.

2.2.4 Monitoring Results

As previously discussed, continuous air monitoring was conducted by the on-site industrial hygienist (IH) to ensure personnel health and safety, and to ensure that adequate work control boundaries had been established during the polyurea application process. MSA Escort Elf sampling pumps were located in the demonstration area, downwind of the demonstration area, and were worn by the applicator. The pumps contained treated filters that collected airborne particulates and contaminants. For the demonstration, the contaminant of concern was methylene biphenyl isocyanate (MDI) (one component of the polyurea). Throughout the demonstration and after each demonstrated area was complete, the filters were removed from the sampling pumps and submitted to Schnieder Laboratories in Richmond, Virginia for analysis. Occupational Safety and Health Administration (OSHA) sampling method 42 was used. All sample results were below the American Conference of Governmental Industrial Hygienists threshold limit value of 0.005 ppm and the OSHA permissible exposure limit of 0.020 ppm for MDI. A summary of the analytical results is provided in the Table 2-1.

Table 2-1. Summary of analytical results.

Sample Number	PPM (Metyhlene biphenyl isocyanate)	Location and Type
April 28, 2000		
PUD01	<MQA	Within work control zone
PUD02	<MQA	Within work control zone
PUD03	0.0008	Within work control zone
PUD04	0.0018	Personal (polyurea applicator)
PUD05	<MQA	Personal (worker at spray trailer)
May 12, 2000		
PUD07	<MQA	Within work control zone
PUD08	0.0005	Within work control zone
PUD09	<MQA	Within work control zone
PUD10	0.0024	Personal (polyurea applicator)
May 19, 2000		
PUD12	0.0003	Within work control zone
PUD13	<MQA	Within work control zone
PUD14	0.0017	Within work control zone
PUD15	0.0039	Personal (polyurea applicator)

PPM – parts per million

MQA – Minimum Quantifiable Amount

3. PERFORMANCE CRITERIA

The performance criteria selected for this demonstration include durability, strength, flexibility, safety, ease of application, bonding, and aesthetic appeal. A brief explanation of how these have been defined for the purposes of the polyurea demonstration follows.

3.1 Durability

The durability of each of the products was evaluated by placing them in a high traffic area. High traffic is defined as at least daily occurrences of foot traffic, normal vehicle traffic (defined as pickups or cars driving across the demonstrated areas a minimum of four times/day). Product durability was evaluated by inspecting for cracks, tears, and degradation of the surface from on-going traffic. The edges of the installation were also examined to ensure they remained bonded to various protrusions without pulling away (adhesive characteristics).

3.2 Strength

The strength of each of the products was evaluated by determining the ability of the product to withstand extreme loading conditions. In order to assess occasional occurrences of heavy equipment which can reasonably be expected on the tank farm (AEC, 1993), a trackhoe weighing approximately 35,000 pounds (representing the greatest concentrated load) and a crane (Grove 150) weighing 190,000 pounds (representing the greatest total distributed load) was driven over the test area. Strength was evaluated by examining how the product performed under this type of heavy loading, especially in the uncompacted gravel areas. Surfaces were examined for holes and tears.

3.3 Flexibility

The flexibility or elasticity of the various products was evaluated during the demonstration period by applying the polyurea to various protrusions and buildings adjacent to the demonstration area. This criteria was also evaluated by examining the material that was placed on the uncompacted gravel surface, running heavy loads over it, and inspecting the nearby protrusions to see if the material remained adherent.

3.4 Safety

The various products were evaluated for safety purposes since both foot and vehicle traffic contacted the surface. The vendors were to ensure a high friction surface, by whichever method they normally employ, and the ability to drive and walk on the material in different weather conditions was evaluated. Significant buckling resulting from an improperly anchored geotextile, which creates tripping or slipping hazards from accumulated water, snow or ice, and/or access problems will also be assessed as practiced.

3.5 Ease of Application

Each of the vendors' methods was evaluated for ease of application. This criterion was evaluated by inspecting both the application of the underlying geotextile and the application of the polyurea. The procedure for anchoring the geotextile to the road base and uncompacted gravel was also evaluated to determine if it can be easily disturbed following placement but prior to application of the polyurea, or during polyurea application. Ease of application is relevant since it is expected that repairs to the final application will be necessary due to maintenance and construction activities.

3.6 Bonding

The effectiveness of the products to bond to various materials including the geotextile, road base, uncompacted gravel, miscellaneous protrusions, and building foundations were evaluated as part of the demonstration. A combination of existing conditions and those simulated for demonstration purposes were utilized.

3.7 Aesthetic Appeal

Aesthetics were important to evaluate as part of the demonstration because the spray-on material will cover the entire tank farm area as well as areas within the 150-ft zone surrounding the tank farm. Because the material will cover a large area, it is important that it be visually acceptable to those who visit and work at the facility.

As previously discussed, UV protection was applied to approximately one half of Areas 2, and 3. The other half of the areas remain unprotected. The effects of UV rays were assessed between the coated and uncoated areas for aesthetic appeal, as was practical for the short duration of the demonstration. As reported by the manufacturers, UV rays may cause the uncoated portion of the area to change color and the first few millimeters to chalk, but the overall performance should not be affected. Because the UV coating would add a significant cost to the TFIA cover and does not enhance cover performance, it has been omitted from the specifications.

The demonstration requirements to meet the performance criteria described above are presented in Table 3-1. Failing one or more of the performance criteria is not necessarily grounds for disqualification of the polyurea product. Under certain circumstances, required maintenance such as patching, may be acceptable.

Table 3-1. Spray-on demonstration requirements.

Demonstration Requirements	Performance Criteria						
	Durability	Strength	Flexibility	Safety	Ease of Application	Bonding	Aesthetic Appeal
Asphalt	X	X	X	X	X	X	X
Road Base	X	X	X	X	X	—	X
Loose Gravel	X	X	X	X	X	—	X
Heavy Traffic	X	—	X	X	—	—	—
High Loading	—	X	X	—	—	—	—
High Friction Surface	—	—	—	X	X	—	X
Attachment to Buildings	X	—	X	—	X	X	—
Attachment to Protrusions	X	—	X	—	X	X	—
Ultraviolet top coat	—	—	—	—	—	—	X

4. PERFORMANCE CRITERIA ASSESSMENT

During the assessment period, daily occurrences of foot and vehicular traffic populated the demonstration area (during the normal work week at INTEC), as required under the durability criteria. Personnel walked over the demonstration area and ensured that vehicles were driven over the area at least four times/day. Three traffic counters were also installed at different locations within the demonstration area.

On August 11, 2000, a trackhoe and a crane were driven over the demonstration area, as required under the strength criteria. The crane was a Grove 150, weighing 190,000 pounds, and is the crane that is used in the tank farm. The trackhoe was a Hitachi EX200, weighing approximately 35,000 pounds. The trackhoe is similar to the one used in the tank farm; the actual trackhoe used in the tank farm is an older model than the one used in this demonstration.

The crane did not cause any damage to the polyurea. The trackhoe however, tore through all three of the polyurea products, when the tracks were turned, but did not cause any damage when driven straight across the demonstration area.

Table 4-1 summarizes the performance criteria assessment for Areas 1, 2, and 3 using an alphanumeric rating system as follows: A = excellent, B = good, C = fair, D = poor, 1 = complex, 2 = moderate, and 3 = easy. The text which follows provides clarification for any item rated B or below.

4.1 Strength

4.1.1 Area 1

The polyurea in Area 1 rated good for strength overall under the high loading requirement because the trackhoe damaged the area when the tracks were turned various directions. The trackhoe, however, did not damage the polyurea coating when driven straight across the demonstration area.

The 190,000 pound Grove 150 crane did not damage the polyurea when driven across the area. An overall B rating was therefore assigned.

4.1.2 Area 2

The polyurea in Area 2 rated good for strength overall under the high loading requirement because the trackhoe damaged the area when the tracks were turned various directions. The trackhoe, however, did not damage the polyurea coating when driven straight across the demonstration area.

The 190,000 pound Grove 150 crane did not damage the polyurea when driven across the area. An overall B rating was therefore assigned.

4.1.3 Area 3

The polyurea in Area 3 rated good for strength overall under the high loading requirement because the trackhoe damaged the area when the tracks were turned various directions. The trackhoe, however, did not damage the polyurea coating when driven straight across the demonstration area.

The 190,000 pound Grove 150 crane did not damage the polyurea when driven across the area. An overall B rating was therefore assigned.

Table 4-1. Performance criteria assessment for Areas 1, 2, and 3.

	Performance Criteria						
Demonstration Requirements	Durability	Strength	Flexibility	Safety	Ease of Application	Bonding	Aesthetic Appeal
Asphalt	Area 1 – A Area 2 – A Area 3 – A	Area 1 – A Area 2 – A Area 3 – A	Area 1 – A Area 2 – D Area 3 – D	Area 1 – D Area 2 – D Area 3 – D	Area 1 – 2 Area 2 – 2 Area 3 – 2	Area 1 – A Area 2 – A Area 3 – A	Area 1 – A Area 2 – A Area 3 – C
Road Base	Area 1 – A Area 2 – A Area 3 – A	Area 1 – A Area 2 – A Area 3 – A	Area 1 – D Area 2 – A Area 3 – A	Area 1 – D Area 2 – C Area 3 – C	Area 1 – 2 Area 2 – 2 Area 3 – 2	—	Area 1 – A Area 2 – A Area 3 – C
Loose Gravel	Area 1 – A Area 2 – A Area 3 – A	Area 1 – A Area 2 – A Area 3 – A	Area 1 – A Area 2 – A Area 3 – A	Area 1 – D Area 2 – C Area 3 – C	Area 1 – 2 Area 2 – 2 Area 3 – 2	—	Area 1 – A Area 2 – A Area 3 – C
Heavy Traffic	Area 1 – A Area 2 – A Area 3 – A	—	Area 1 – A Area 2 – A Area 3 – A	Area 1 – A Area 2 – A Area 3 – A	—	—	—
High Loading	Area 1 – A Area 2 – A Area 3 – A	Area 1 – B Area 2 – B Area 3 – B	Area 1 – C Area 2 – C Area 3 – C	—	—	—	—
High Friction Surface	—	—	—	Area 1 – D Area 2 – C Area 3 – C	Area 1 – N/A Area 2 – 2 Area 3 – 3	—	Area 1 – D Area 2 – A Area 3 – C
Attachment to Buildings	Area 1 – A Area 2 – A Area 3 – A	—	Area 1 – A Area 2 – A Area 3 – A	—	Area 1 – 3 Area 2 – 2 Area 3 – 2	Area 1 – A Area 2 – A Area 3 – C	—
Attachment to Protrusions	Area 1 – A Area 2 – A Area 3 – A	—	Area 1 – A Area 2 – A Area 3 – A	—	Area 1 – 3 Area 2 – 2 Area 3 – 2	Area 1 – A Area 2 – A Area 3 – A	—
Ultraviolet effects	—	—	—	—	—	—	Area 1 – D Area 2 – A Area 3 – A

4.2 Flexibility

4.2.1 Area 1

During an inspection performed on August 10, 2000, deep cracks adjacent to the protrusion located in the road base area were observed in the polyurea. The polyurea therefore rated poor for flexibility in this one area.

The polyurea in Area 1 rated fair for flexibility under the high loading requirement because the trackhoe damaged the surface when the tracks were turned various directions.

4.2.2 Area 2

The polyurea in Area 2 rated poor for flexibility in the asphalt area because the asphalt was pulled up at the termination point during the curing and/or expansion/contraction processes. The resulting damage was deemed a safety hazard and required repair.

The polyurea in Area 2 rated fair for flexibility under the high loading requirement because the trackhoe damaged the surface when the tracks were turned various directions.

4.2.3 Area 3

The polyurea in Area 3 demonstrated poor flexibility in the asphalt area as follows: during the curing and/or expansion/contraction processes, the asphalt was pulled up at the termination point creating a tripping hazard. Subsequent repair and removal of a portion of the applied product in this area was required.

The polyurea in Area 3 rated fair for flexibility under the high loading requirement because the trackhoe damaged the surface when the tracks were turned various directions.

4.3 Safety

4.3.1 Area 1

The polyurea in Area 1 rated D for safety in the asphalt, road base, gravel, and high friction surface areas because the application of a high friction surface was not demonstrated. Installation of non-skid tape was required to ensure the safety of pedestrian personnel.

4.3.2 Area 2

The polyurea in Area 2 rated C for safety overall in the road base, gravel, and high friction surface areas because some of the sand applied to ensure a high friction surface was not imbedded in the polyurea and therefore did not remain adherent to the polyurea surface. It should be noted, that the light spray texture demonstrated in one section of Area 2 was deemed poor, and non-skid tape was installed to ensure the safety of pedestrian personnel. For the area closest to CPP-654, where #12 silica sand was broadcast at approximately 100% density, the friction surface was excellent. An overall C rating was therefore assigned to these areas.

The polyurea in Area 2 rated D for safety in the asphalt area because it pulled up the asphalt on Cedar Street creating a tripping hazard which required subsequent repair.

4.3.3 Area 3

The polyurea in Area 3 rated D for safety in the asphalt area because it pulled up the asphalt on Cedar Street creating a tripping hazard which required subsequent repair and removal of a portion of the applied product. The surface rippling caused water to puddle, creating a slipping hazard. In the road base and gravel areas, a C rating was assigned due to the high friction surface which was deemed fair for pedestrian traffic. The area containing the UV topcoat was particularly slippery.

4.4 Bonding

4.4.1 Area 3

The polyurea in Area 3 rated fair for attachment to buildings due to shrinkage at the TB-6 interface, which resulted in a large air pocket between the building, the ground, and the polyurea coating. Over time, it appears that continuous pulling due to the weight of pedestrians and/or vehicular traffic in this area would result in the material separating away from the building surface.

4.5 Aesthetic Appeal

4.5.1 Area 1

The polyurea in Area 1 rated poor in aesthetic appeal for the high friction surface and the UV top coat, because these requirements were not demonstrated.

4.5.2 Area 3

The polyurea in Area 3 rated fair for aesthetic appeal in all areas due to the fogging method used to apply the high friction surface which resulted in an uneven distribution in size, shape, and coverage of the polyurea droplets. In addition, significant surface ripples from expansion/contraction occurred in the area, and the anchors used on the edges of the geotextile protrude above the ground surface. This required additional polyurea to cover, and resulted in more pronounced stakes and the appearance of less tidy edging.

5. SUMMARY

Polyurea used in this application demonstrated good flexibility, strength, durability, and bonding to various surfaces. Performing the three vendor demonstrations resulted in valuable information which has been included in the construction plans and specifications for the OU 3-13 Tank Farm Interim Action. Areas of improvement are required for application of a high friction surface, asphalt terminations, and application of polyurea in windy conditions. Plans for improvement in these areas are in progress.

Continuing performance observations may be conducted during the winter unless conditions warrant removal of the polyurea from the test areas. If possible, continued observations will be performed to (1) continue to observe traffic effects over a longer period, (2) assess safety issues in winter conditions, (3) determine how winter conditions affect the polyurea and (4) modify specifications, as required.

6. REFERENCES

DOE-ID 1999, *Final Record of Decision, Idaho Nuclear Technology and Engineering Center, Operable Unit 3-13*, DOE/ID-10660, Department of Energy Idaho Operations Office, October.

Advanced Engineering Consultants, Inc., 1999, *Evaluation of Existing Vaults for Vehicle Loads, HLWTFR Project*, AEC Report No. 1002-08, August.

Jessmore, 2000, *Operable Unit 3-13 Tank Farm Interim Action Group 1 Soils Decision Analysis Study*, Engineering Design File EDF-ER-115, January.

APPENDIX A

Spray-On Polyurea Demonstration Plan

OU 3-13 Group 1
Tank Farm Interim Action

Spray-On Polyurea Demonstration Plan

OU 3-13 Group 1 – Tank Farm Interim Action

1. INTRODUCTION

The Operable Unit (OU) 3-13 Group 1 Soils, are soils at the Idaho Nuclear Technology and Engineering Center (INTEC) (Figure 1) within the Tank Farm fence in addition to soils within a 150-ft zone surrounding the Tank Farm. The area within the fence is approximately 200,000 ft^2 (4.60 acres) and the area within the 150-ft zone is approximately 160,000 ft^2 (3.67 acres). Previous operations within the Tank Farm have resulted in known areas of soil contamination. The major threat associated with these soils is the potential leaching and transport of contaminants to the perched water or to the Snake River Plain Aquifer. The OU 3-13 Interim Action is designed to mitigate this risk until a final remedy is developed and implemented. The selected Tank Farm Interim Action is Institutional Controls with Surface Water Control. The major components of this remedy include:

- Restrict access to control exposure to workers and prevent exposure to the public from soils at the Tank Farm until implementation of the final remedy under OU 3-14
- Accommodate a 1 in 25-year, 24-hour storm event with surface water run-on diversion channels
- Minimize precipitation infiltration by grading and surface sealing the tank farm soils sufficient to divert 80% of the average annual precipitation falling on the tank farm soils area, and
- Improve exterior building drainage to direct water away from the contaminated areas,as promulgated in the OU 3-13 Final Record of Decision.

During the OU 3-13 scoping process, various surface sealing options were evaluated for minimizing precipitation infiltration. On November 18, 1999, the information gathered during the scoping process was presented at a facilitated Decision Analysis Meeting to 1) discuss the options evaluated for surface sealing/covering the Tank Farm, 2) identify additional options, if any, 3) identify evaluation criteria, 4) select a recommended option, and 5) identify the risk associated with the recommendation. The recommended option selected is polyurea, which is a spray on applied impermeable product. During the meeting it was recommended that a test section of the material be constructed at the site to determine product performance and bonding capabilities to various materials. This demonstration will be performed to assess various performance criteria, as discussed in Section 8, using polyurea applied by three separate vendors. Engineering Design File (EDF-ER-115) contains the information assimilated during the Decision Analysis Meeting.

2. OBJECTIVES

The objectives of this demonstration are; 1) to identify and assess minimum acceptable performance criteria for inclusion in the Tank Farm Interim Action (TFIA) construction specifications, as discussed in Section 8, and 2); recommend a polyurea to surface seal the Tank Farm Area and areas within 150 feet of the Tank Farm fence. This will direct/control precipitation run-on away from the Tank Farm area, as mandated in the OU 3-13 Record of Decision.

3. DEMONSTRATION AREA

The field demonstration will be performed at the Idaho Nuclear Technology and Engineering Center (INTEC), adjacent to building CPP-654. The approximate area to be covered during each vendor demonstration is 900 ft^2 (i.e., total area = 3(900) = 2,700 ft^2). A map of the demonstration area indicating the area(s) to be covered by each vendor is included as Figure 2. Table 3-1 shows the subcontractor, order of application, polyurea color to be applied and designated area as it relates to Figure 2.

Each of the three demonstrations will be conducted adjacent to one another under similar conditions (i.e. field conditions) to ensure the evaluations are comparable. The first subcontractor will be required to anchor the edges of his installation as if there were to be no other applications. The second and third subcontractors may anchor edges adjacent to existing applications either by anchoring to the previously installed product or by creating their own edge abutting the existing. The vendors are required to demonstrate a geotextile seam in at least one location within their demonstration area.

During the demonstration, the three products will each be applied to three types of surfaces with above grade protrusions representative of those which exist in the Tank Farm and surrounding area. The three surfaces are:

- Asphalt
- Road Base
- Uncompacted Gravel

Each product will also be applied to a wood and/or metal protrusion and against buildings TB-6 and CPP 654 (see Figure 2), to approximately 1 ft up the side of the buildings.

A subsurface investigation has been performed to locate underground utilities within the demonstration area. All utility lines are well beneath the surface with the exception of one electrical ductbank. There is one 2.4 kv line encased in red concrete which transects the demonstration area parallel to and approximately ten feet south of building TB-6. This ductbank is 22 inches below the surface in the uncompacted area and 14 inches below the surface in the compacted area. The ductbank may be an issue for installation of anchors at this location which exceed those depths.

Table 3-1. Subcontractor, order of application, polyurea color to be applied and designated area.

Subcontractor	Order of Application	Area	Polyurea Color
General Polymers	First	3	Black
Stonhard	Second	2	Silver Gray
Sherwin Williams	Third	1	Yellow

4. APPLICATION REQUIREMENTS

Each of the demonstrated products will be applied over an anchored geotextile (for road base and uncompacted gravel areas only) to a thickness of approximately 125 mil (1/8 in). Geotextile will not be used on asphalted areas, but may extend part way up the building foundations. The demonstrated products will vary in color so that they can be distinguished from one another and to aid in color selection for the final Tank Farm area application. Each vendor will apply an ultraviolet protectant to approximately half of their area.

All applications will be performed by the individual vendors, and all materials and services provided, at no charge for the purposes of demonstration.

5. HEALTH AND SAFETY REQUIREMENTS

Vendor personnel will be required to wear a respirator and protective clothing during the polyurea application process, as prescribed by the material safety data sheets (MSDSs) and the on-site Industrial Hygienist (IH). The subcontractor may supply the necessary protective equipment, subject to INEEL approval, or it can be provided.

5.1 Work Control Zone

A work control zone will be established by the on-site IH, in conjunction with the INTEC IH, surrounding the application area. The specific configuration and distance from the application area will be determined from chemical properties, environmental conditions (wind speed, direction, temperature) and application methods jointly by the on-site and INTEC IH. The INTEC IH will help determine appropriate building ventilation controls to eliminate potential adjacent building occupant exposure.

Appropriate barricades and signs will be utilized to establish an effective access control to the application area. Only trained, authorized persons equipped with specified personal protective equipment (PPE) will be allowed to enter the work control zone.

Cleanup of the demonstration area is required on a daily basis. Waste and debris are not allowed to accumulate in such quantities as to create an unsightly appearance, a safety or fire hazard, nor shall it interfere in any way with free access to, or operation of, existing facilities. All materials brought on-site as well as waste generated, shall be removed by the vendor at the conclusion of their portion of the demonstration, with the exception of the actual application materials.

5.2 Industrial Hygiene (IH) Monitoring

The on-site IH will conduct initial and periodic monitoring for chemical contaminants identified in the material safety data sheets (MSDSs) for Polyurea, the UV protectant, abrasive coating, and other chemicals as appropriate. Monitoring may also be conducted outside the work control zone to determine potential product drift for perimeter protection verification. Work control zones will be established by the on-site IH based on controls identified in section 5.1, Work Control Zone, and on monitoring results.

5.3 Required Training

Table 5-1. Training Requirements. Each of the vendor personnel performing work on-site will need the following **current** training/qualifications:

Training	Course No.	Length of Training	Availability	Notes
Respirator[1]	TRN 4 and TRN 6	2.5 hrs	On-site	Cover full face, airline/bubble suit, and quantitative fit test
Orange card (incl. HAZ Com.)	N/A	2.0 hrs	On-site (given every day)	Covers GERT and site access
PPE	TRN 288 or TRN 512	1.5 hrs	On-site	
Hearing conservation	TRN 32	1.0 hrs	On-site	
Physical Examination[2] (within past 12 months)		2.0 hrs	local doctor	Must include OSHA requirements
JSA (posting requirements, heat and cold stress, etc.)		1.5 hrs	Training will be provided prior to start of work	

1 – Individuals who have DOE approved respirator training may not be required to attend TRN4 if training is current and proof of training is provided.

2- Proof of current physical examination must include respirator requirements and be submitted prior to arrival at the INEEL.

Proof of current training (i.e., certificate or card) is required and will be submitted by the subcontractors prior to arrival at the site or acquired on-site prior to the demonstration.

6. UTILITY REQUIREMENTS

The vendors have indicated that three phase, 480 volt power is required. A power generator and a breathing air compressor will be provided by the facility, or the subcontractors may supply their own, subject to ensuring all on-site equipment requirements are met. Other equipment such as power washers and spray applicators will be supplied by the subcontractors.

7. LIMITING DEMONSTRATION CONDITIONS

The following conditions are limiting conditions to be imposed on the demonstration. While the product itself is not typically restricted under these conditions, they have been selected as limiting conditions because the polyurea will not be applied under these conditions during actual application in the Tank Farm and surrounding areas, and for health, safety and industrial hygiene reasons.

7.1 Standing Water

The demonstration will not be performed in areas containing standing water. Where feasible, standing water will be removed prior to application.

7.2 Wind

The demonstration will not be performed if the wind carries unacceptable levels of the polyurea product beyond the work zone, or if wind speeds exceed levels based on manufacturers recommendations and as evaluated by the on-site IH. The demonstration may be delayed or terminated at the discretion of the on-site IH until allowable wind speeds, as measured at the work location, are achieved.

7.3 Snow

The product will not be applied over snow or if snow is accumulating during the application. Where necessary and feasible, snow will be removed by INTEC laborers prior to application.

8. PERFORMANCE CRITERIA

The following performance criteria to be evaluated as part of this demonstration have been chosen based on the final application of the spray-on product in and around the Tank Farm area. Criteria to be evaluated during this demonstration include:

- durability
- strength
- flexibility
- safety
- ease of application
- bonding
- aesthetic appeal.

Each of these criteria will be evaluated for the three demonstration areas every two weeks for a designated period of time. Additionally, inspections may be performed after storms or as deemed necessary.

The following sections describe each of the above listed criteria and how these criteria will be evaluated during the demonstration.

8.1 Durability

The durability of each of the products will be evaluated by placing them in a high traffic area. High traffic is hereby defined as at least daily occurrences of foot traffic, normal vehicle traffic (defined as pickups or cars driving across the demonstrated areas a minimum of four times/day). Product durability will be evaluated by inspecting for cracks, tears, and degradation of the surface from on-going traffic. The edges of the installation will also be examined to ensure they remain bonded to various protrusions without pulling away (adhesive characteristics).

8.2 Strength

The strength of each of the products will be evaluated by its ability to withstand extreme loading conditions. In order to assess occasional occurrences of heavy equipment which can reasonably be expected on the Tank Farm, (reference: AEC Report No. 1002-08, April 1, 1994 "Tank Farm Loading Study") a track hoe weighing 31,000 pounds (representing the greatest concentrated load) and a crane (Grove 150) weighing 190,000 pounds (representing the greatest total distributed load) will be driven over the test area. Strength will be evaluated by examining how the product performs under this type of heavy loading, especially in the uncompacted gravel areas. Surfaces will be examined for holes and tears.

8.3 Flexibility

The flexibility or elasticity of the various products will be evaluated during the demonstration period by applying the polyurea to various protrusions and buildings along the edges of the demonstration area. This criteria will also be evaluated by examining the material that has been placed on the uncompacted gravel surface, running heavy loads over it and, inspecting the nearby protrusions to see if the material remains adherent. Impact of temperature fluctuations will also be monitored, as practical, given the actual meteorological conditions during the demonstration period.

8.4 Safety

The various products will be evaluated for safety purposes since both foot and vehicle traffic will contact the surface. The vendors will ensure a high friction surface, by whichever method they normally employ, and the ability to drive and walk on the material in different weather conditions will be evaluated. Significant buckling resulting from an improperly anchored geotextile, which creates tripping, or slippping hazards from accumulated water, snow or ice, and/or access problems will also be assessed.

8.5 Ease of Application

Each of the vendors' methods will be evaluated for ease of application. This criterion will be evaluated by inspecting both the application of the underlying geotextile on the road base and uncompacted gravel and application directly on asphalt and on the geotextile membrane. The procedure for anchoring the geotextile to the road base and uncompacted gravel will also be evaluated to determine if it can be easily disturbed following placement but prior to application of the polyurea, or during polyurea application. Ease of application is relevant since it is expected that repairs to the final application will be necessary due to maintenance and construction activities.

8.6 Bonding

The effectiveness of the products to bond to various materials including the geotextile, road base, uncompacted gravel, miscellaneous protrusions, and building foundations will be evaluated as part of the demonstration. A combination of existing conditions and those simulated for demonstration purposes will be utilized.

8.7 Aesthetic Appeal

Aesthetics are important to evaluate as part of the demonstration because the spray-on material will cover the entire Tank Farm area as well as areas within the 150-foot zone surrounding the Tank Farm, as stated in Section 1. Because the material will cover a large area, it is important that it be visually acceptable to those who visit and work at the facility.

As previously discussed, ultraviolet (UV) protection will be applied to approximately one half of each of the three demonstrated areas. The other half of the areas will remain unprotected. The effects of UV rays will be assessed between the coated and uncoated areas for asthetic appeal, as practical for the short duration of the demonstration. As reported by the manufactures, UV rays may cause the uncoated portion of the area to change color and the first few millimeters to chalk, but the overall performance should not be affected. Since use of UV coating will add a significant cost to the Tank Farm Interim Action cover, it will only be specified if required.

The demonstration requirements to meet the performance criteria described above are presented in Table 8-1. It should be noted that failing one or more of the performance criteria is not necessarily grounds for disqualification of the polyurea product. Under certain circumstances, required maintenance such as patching, may be acceptable.

Table 8-1. Spray-On Demonstration Requirements

	Performance Criteria						
Demonstration Requirements	Durability	Strength	Flexibility	Safety	Ease of Application	Bonding	Aesthetic Appeal
Surfaces	—	—	—	—	—	—	—
Asphalt	X	X	X	X	X	X	X
Road Base	X	X	X	X	X	—	X
Loose Gravel	X	X	X	X	X	—	X
Heavy Traffic	X	—	X	X	—	—	—
High Loading	—	X	X	—	—	—	—
High Friction Surface	—	—	—	X	X	—	X
Attachment to Buildings	X	—	X	—	X	X	—
Attachment to Protrusions	X	—	X	—	X	X	—
Ultraviolet effects	—	—	—	—	—	—	X

9. FINAL REPORT

A report will be prepared following the demonstration assessment period to document the results of the demonstration and the assessment of the performance criteria. The results (other than business sensitive information) will become part of the final report prepared and distributed prior to the Draft Final Remedial Design/Remedial Action Work Plan.

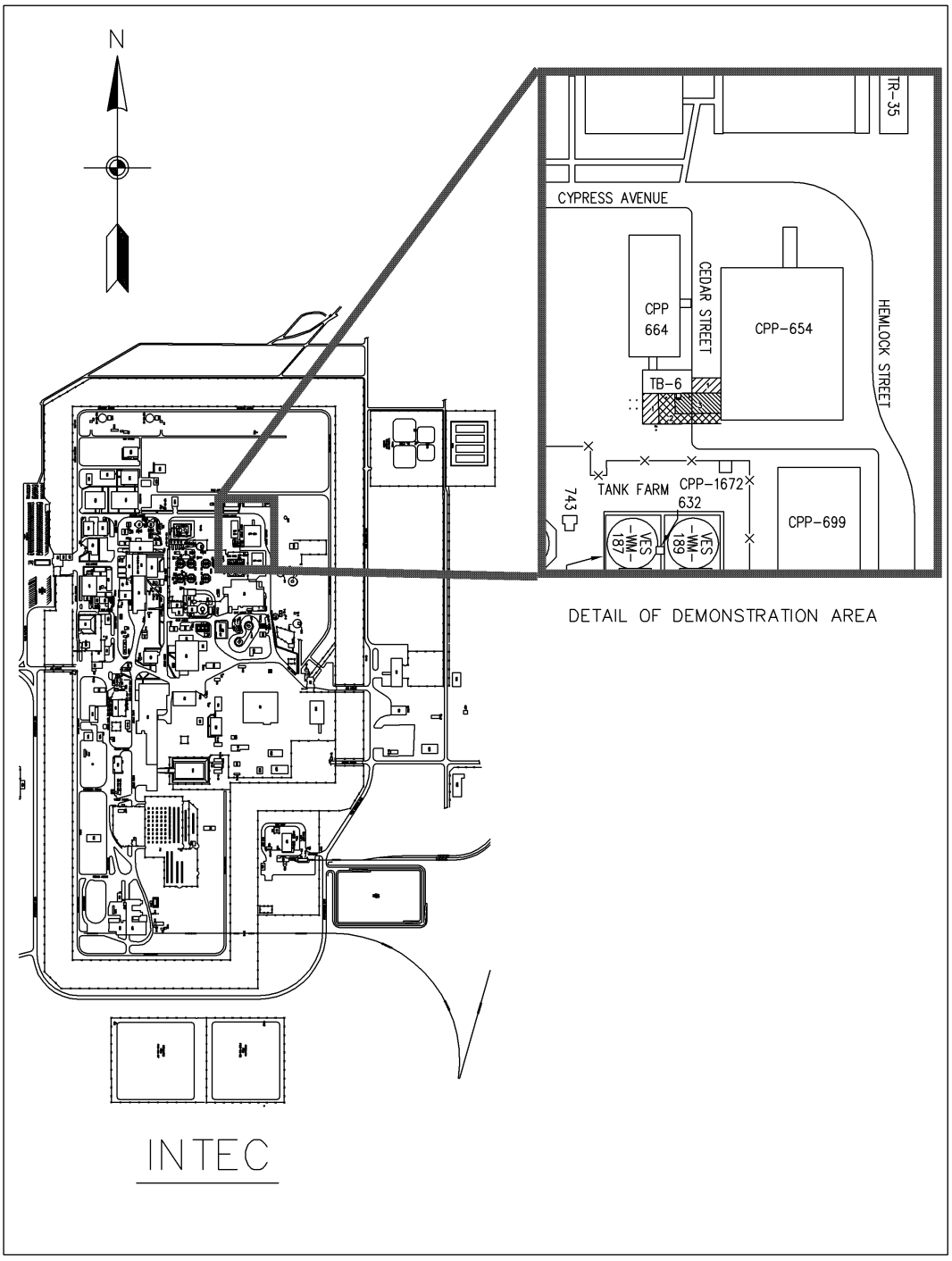


Figure 1. Map of INTEC with demonstration area shown.

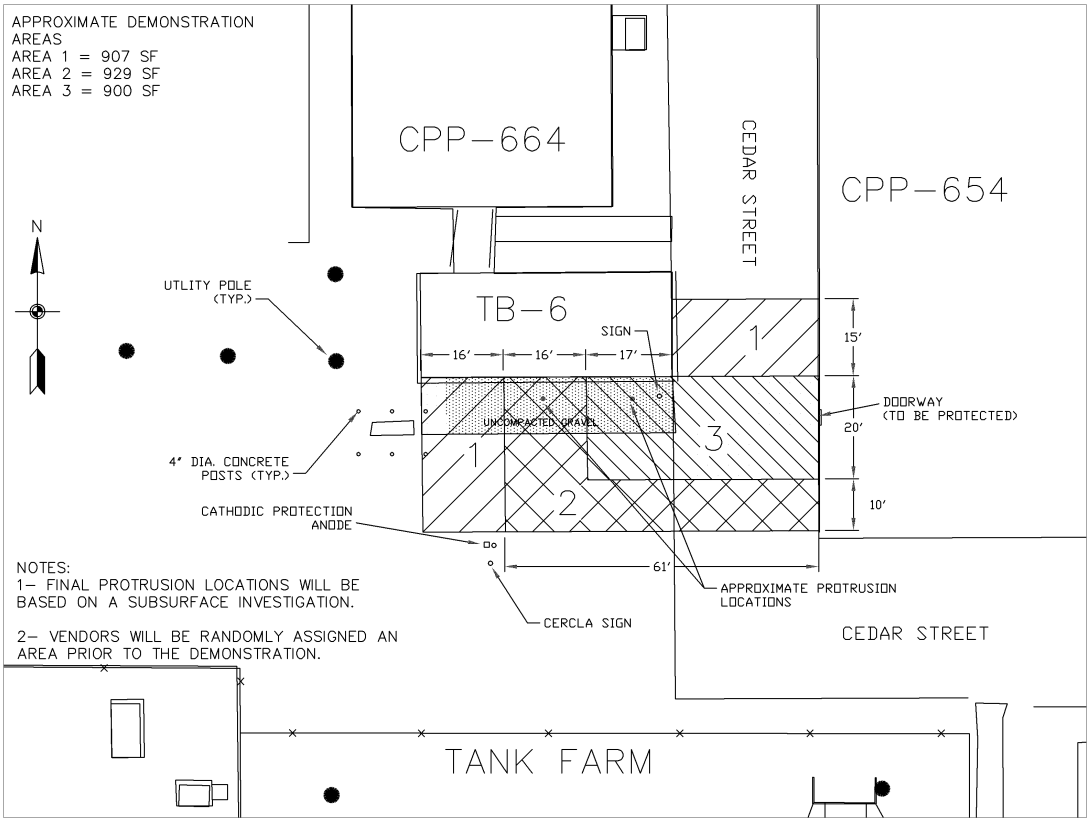


Figure 2. Map of Demonstration Area Indicating Vendor Areas.

APPENDIX B

View of Completed Demonstration Area

View of completed demonstration area, looking Northwest at building TB-6.

View of completed demonstration area, looking Northwest at building TB-6.

View of completed demonstration area, looking East at buildings TB-6 and CPP-654.

APPENDIX C

Area 3, Installation of Geotextile and Polyurea Application

Area 3, installation and achoring of geotextile.

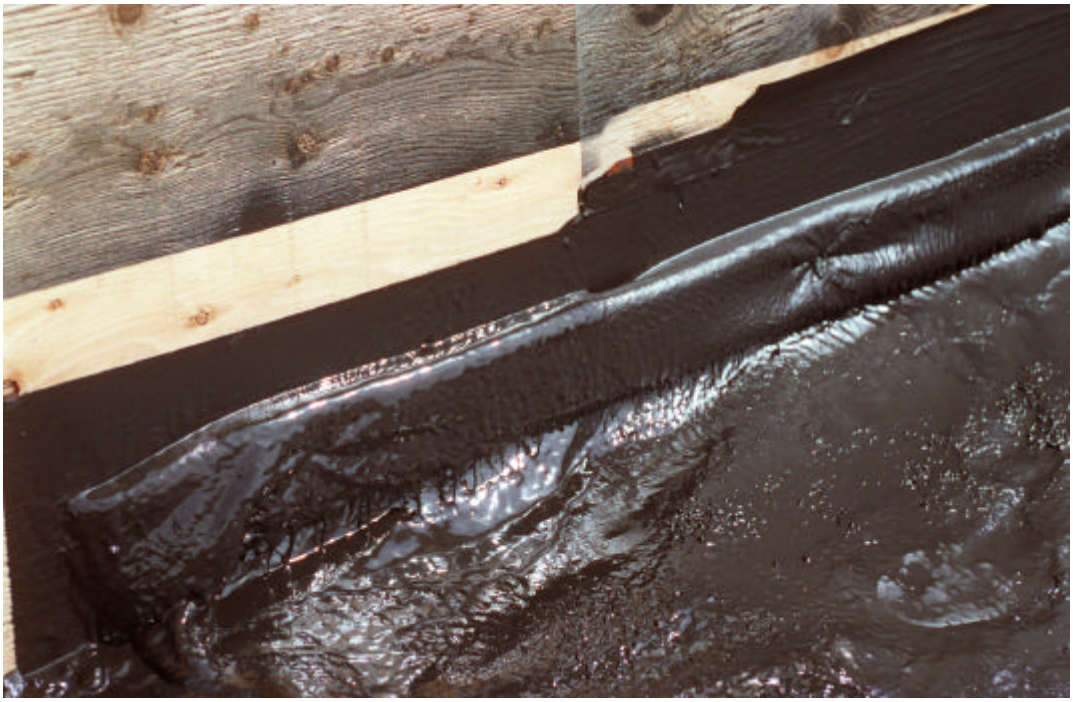
Area 3, geotextile installation completed.

Area 3, application of spray-on polyurea.

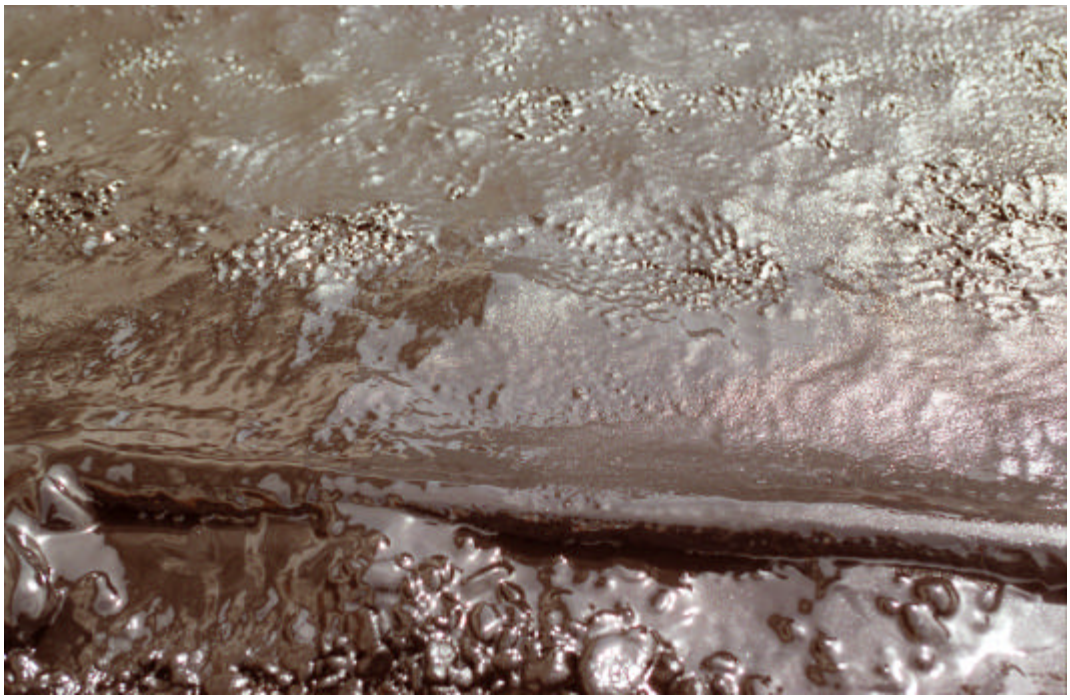
Area 3, polyurea application complete.

Area 3, application of UV topcoat.

Area 3, polyurea applied to protrusion and demonstration of friction surface.



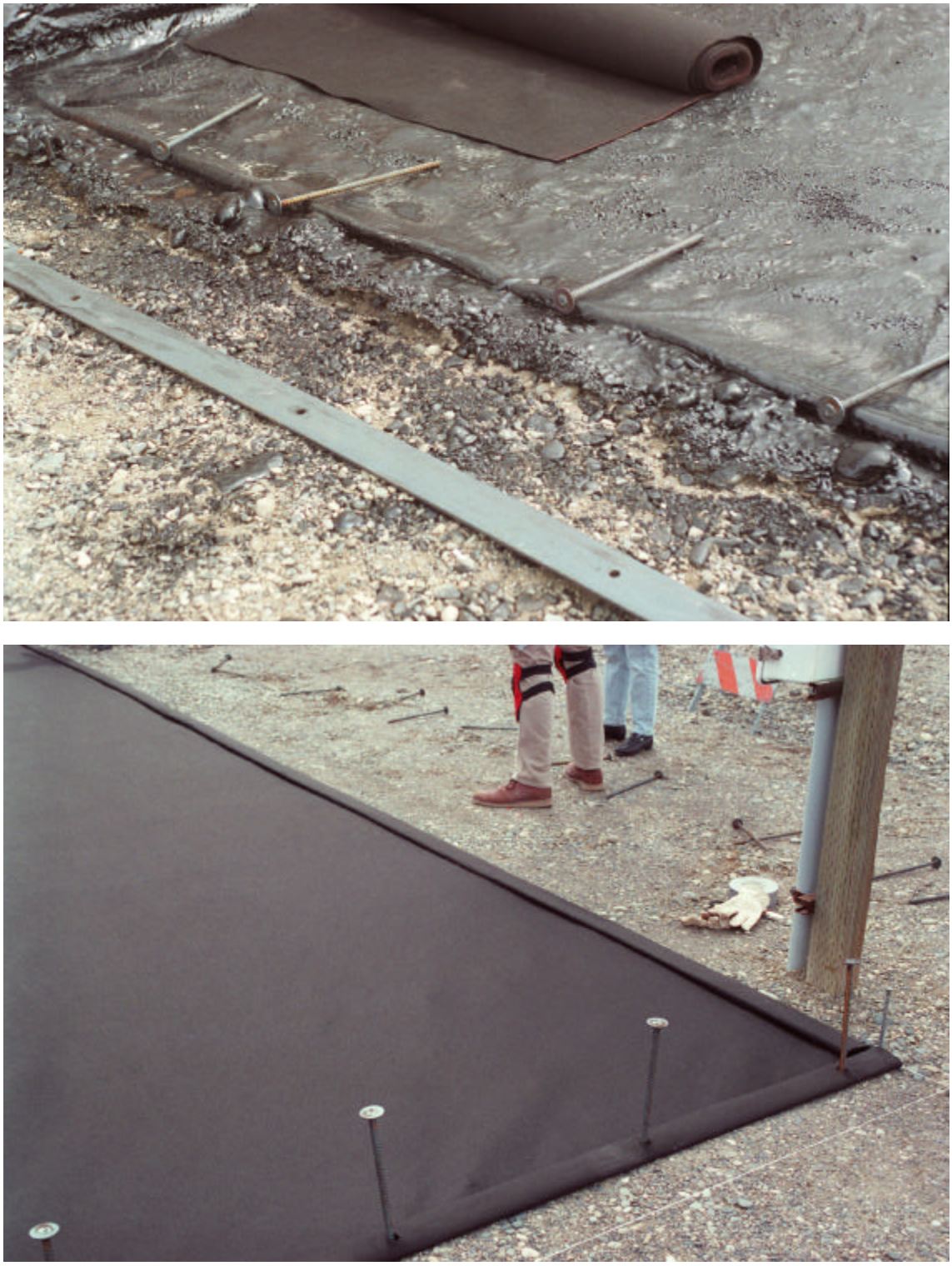
Area 3, attachment of geotextile and polyurea to TB-6.



Area 3, edge detail.

APPENDIX D

Area 2, Installation of Geotextile and Polyurea Application

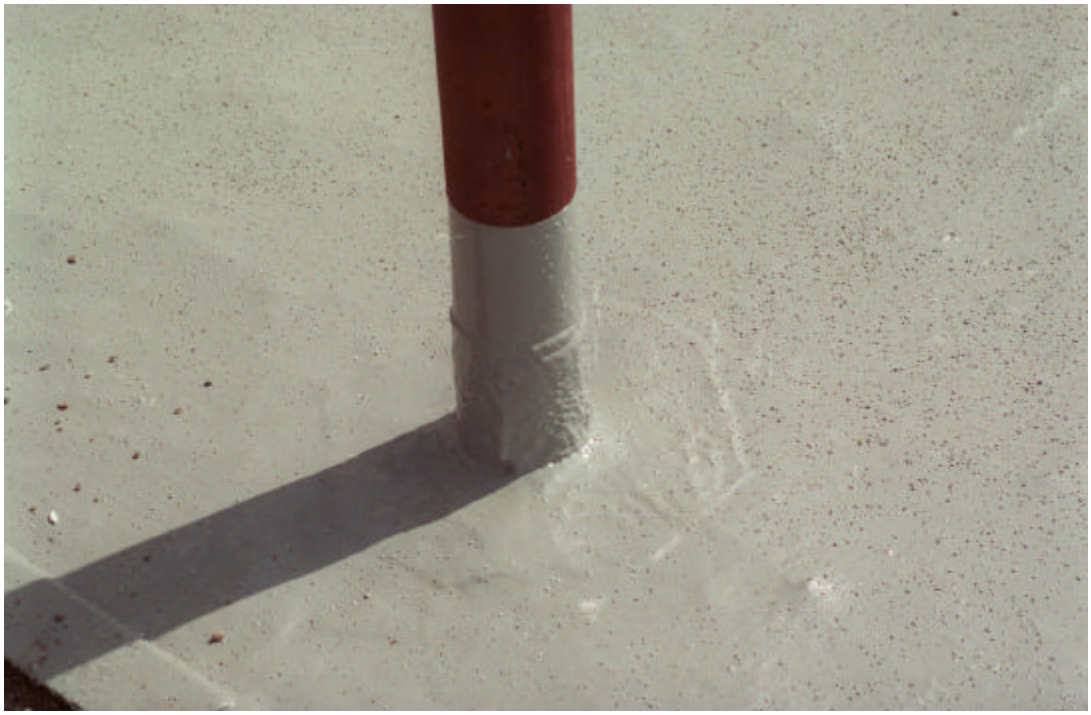


Area 2, installation and anchoring of geotextile.

Area 2, geotextile installation completed.

Area 2, application of spray-on poylurea.

Area 2, polyurea application complete.

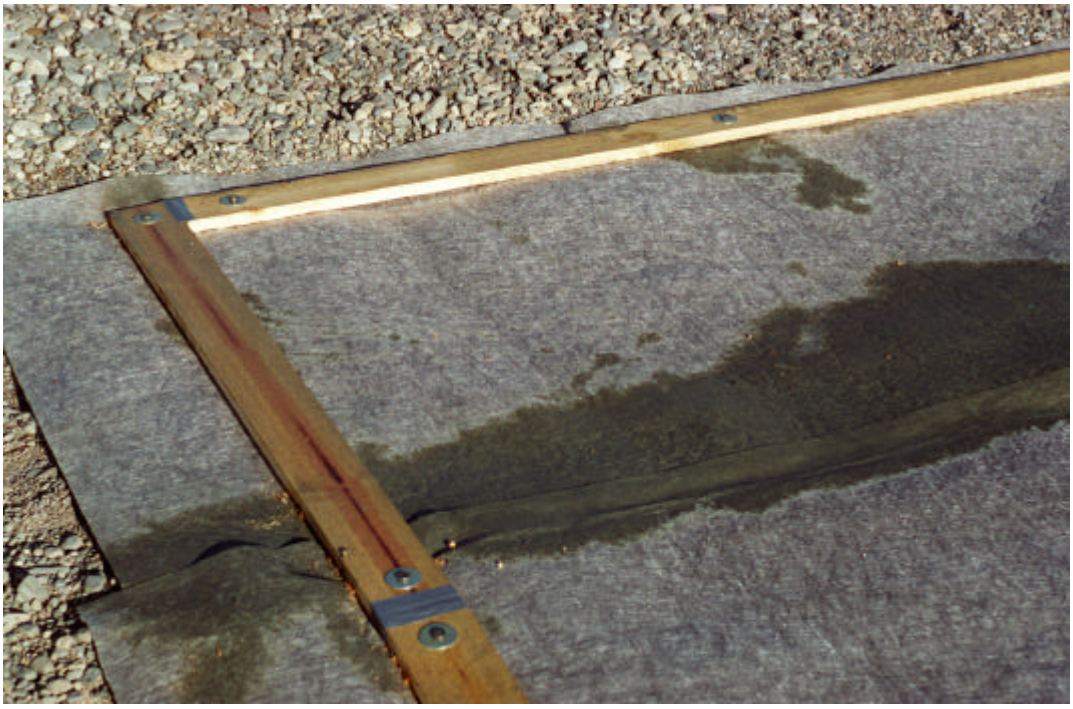


Area 2, polyurea applied to protrusion and broadcasted sand on polyurea surface.

Area 2, edge detail.

APPENDIX E

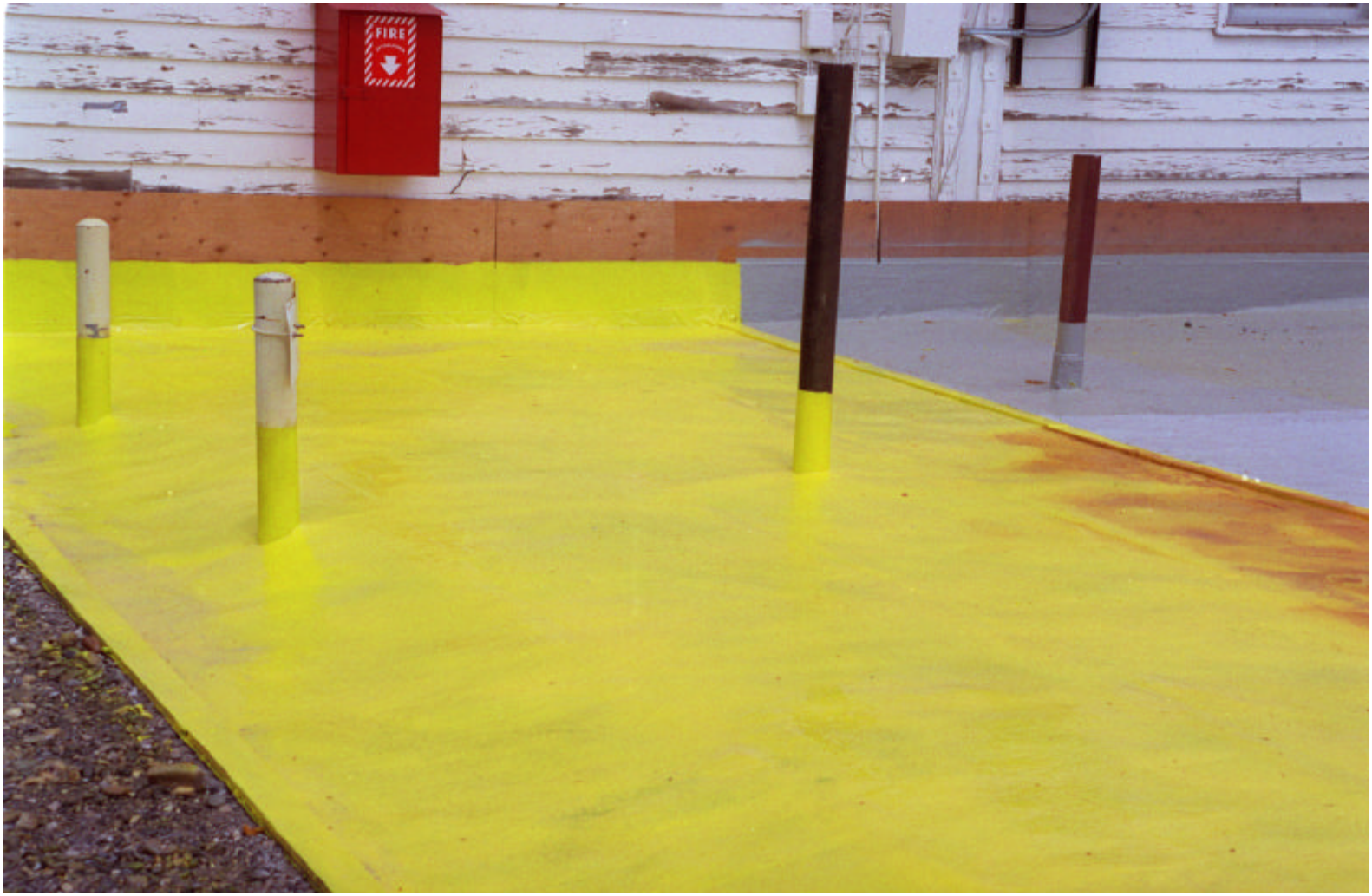
Area 1, Installation of Geotextile and Polyurea Application



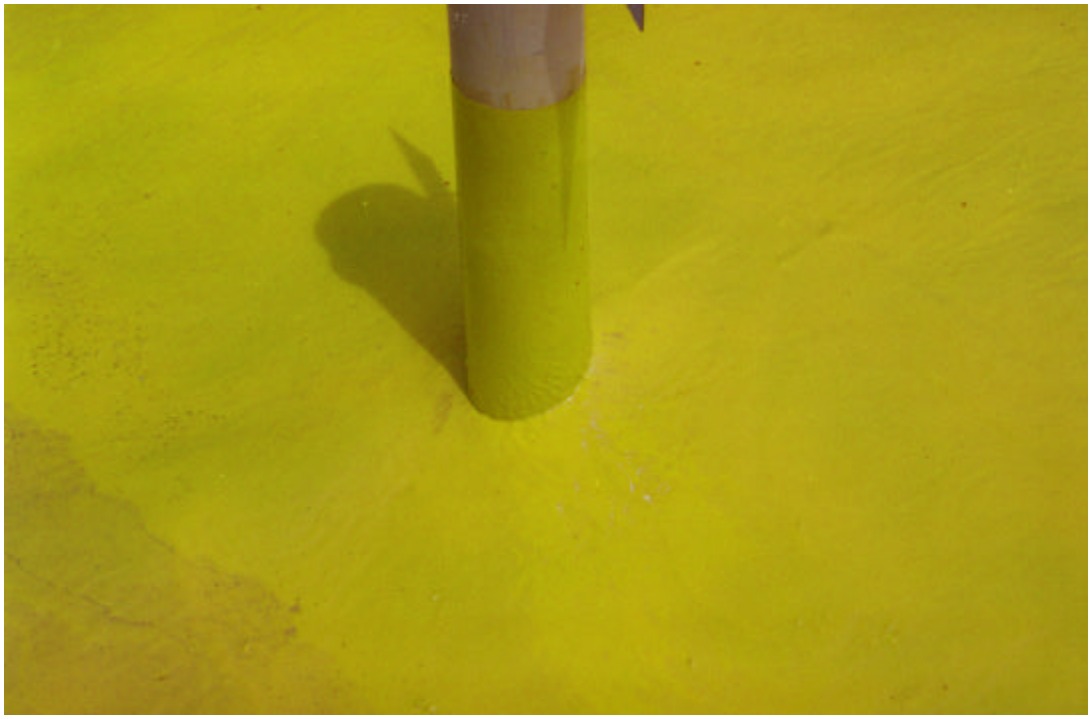
Area 1, installation and anchoring of geotextile.

Area 1, geotextile installation completed.

Area 1, application of spray-on polyurea.



Area 1, polyurea application complete.



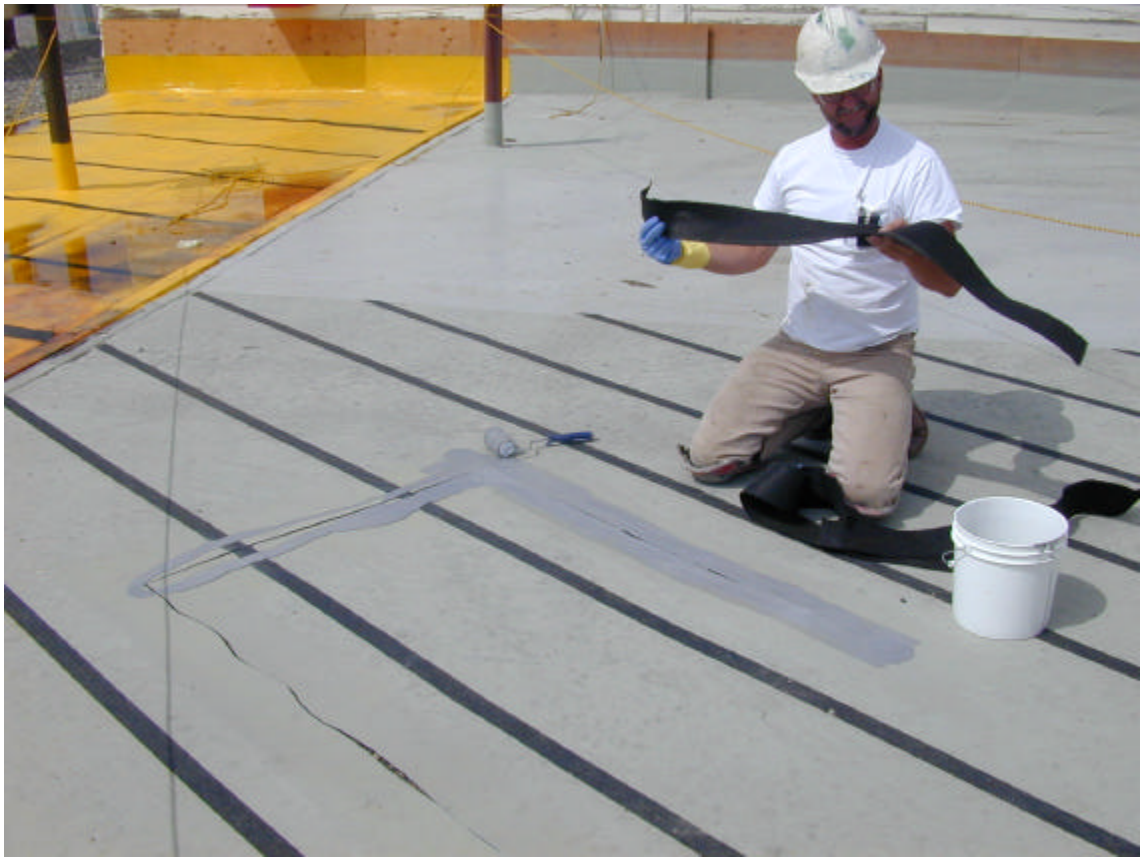
Area 1, polyurea applied to protrusion.

Area 1, edge detail.

APPENDIX F

Area 2 Cut and Repair

Area 2, cut and repair.



Area 2, application of patch.

Area 2, application of patch.

Area 2, application of patch.

Area 2, patch complete.

APPENDIX G

Area 1 Cut and Repair

Area 1, cut and repair.

Area 1, application of patch.

Area 1, application of patch.